

**GUIDELINES BY AN AD HOC EUROPEAN COMMITTEE ON**  
**THE**  
**ASSESSMENT OF GROWTH AND NUTRITIONAL STATUS IN**  
**CHILDREN ON CHRONIC PERITONEAL DIALYSIS**

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## **Abstract**

If children are to thrive and grow on chronic peritoneal dialysis (CPD) they require close attention to their nutritional needs with dietetic support being an essential part of the multidisciplinary team approach. This paper offers a practical approach to the assessment of growth and nutritional status in children on CPD with a combined medical and dietetic strategy.

The nutritional status of each child should be evaluated prior to commencing CPD and at regular intervals thereafter. Anthropometric measurements, particularly weight, length and head circumference should be measured and plotted so that growth velocity can be calculated. Clinical assessment of children should be combined with regular dietary assessments which can be with 3 day dietary diaries or by dietary recall in clinic by an experienced dietitian. Nutrient intakes should be computer analysed and reference made to national guidelines. The nutritional prescription will also consider the dialysis prescription along with biochemical and haematological data as well as relevant medications (phosphate binders, iron and micronutrient supplements and diuretics).

Each child will have individualised nutritional requirements and these should be given by the oral route whenever possible. Failure to meet nutritional intakes or maintain an adequate growth velocity may necessitate the early introduction of enteral feeding via the gastrostomy or nasogastric route. The family and team members must be fully engaged in such decisions with age-related normal weaning, feeding and eating skills being encouraged in infants. Nutritional supplements in use are listed.

Evidence is accumulating that intensive nutritional support and adequate dialysis clearances in pre-pubertal CPD patients promote normal and even enhanced growth without the need for recombinant human growth hormone. Adequate dietetic time is essential to provide this support.

Nutritional assessment and dietetic support is an essential part of the multidisciplinary team approach for children and families on chronic peritoneal dialysis (CPD). This is especially true during infancy where nutritional support via an enteral feeding route is often required<sup>1</sup>.

Children on CPD require frequent nutritional assessment and dietary prescription alongside the prescription of dialysis and medications. Such advice should meet individualised nutritional requirements to maintain nutritional status and promote growth, prevent the build-up of waste products and metabolic abnormalities in accordance with biochemical parameters and should satisfy individual psychosocial needs<sup>2,3</sup>. Assessment by a paediatric renal dietitian is crucial for the close and frequent supervision that is required to monitor and maintain qualitative standards of care for each child because of the changing needs for growth and development<sup>4</sup>.

The European Paediatric Peritoneal Working Group was established in 1999 by paediatric nephrologists with a major interest in peritoneal dialysis<sup>5</sup>. These guidelines were initiated and discussed at meetings of the group and developed through seven drafts by e-mail discussion with the principle authors, one of whom is a senior paediatric renal dietitian (JC). The guidelines are evidence and opinion-based incorporating the cumulative clinical experience of the group members and relevant literature. They are intended as a practical approach to the assessment of growth and nutritional status in children on CPD with a combined medical and dietetic strategy.

#### **A. Nutritional Assessment** (Table 1)

- 1) Clinical staff will assess the nutritional status of individual children with an initial evaluation prior to commencing CPD.
- 2) Further evaluations should take place at clinic visits
  - i) minimum of monthly for infants and children <5 yrs
  - ii) minimum 2-monthly for older children.
- 3) Re-evaluation during ward admissions, particularly during peritonitis episodes
- 4) Telephone contact at home should be available for each family in between ward and clinic visits.<sup>4</sup>
- 5) A visit to home and school/nursery with other team members is beneficial to evaluate the practicalities of treatment.

#### **B. Anthropometry**

- 1) The reliable assessment of growth requires staff who have received training in the use of appropriate measuring techniques and equipment. Measurements should be plotted on reference growth charts for healthy children at baseline and clinic visits thereafter.
- 2) *Weight\** -
  - Infants should be weighed in the nude (monthly)
  - Older children should be weighed in light clothing without shoes

- 3) *Supine Length\** - Recommended up to the age of 2-3 years on a flat surface (Note that change in height difference between recumbent length and standing height is ~ 2.5cm)
- 4) *Standing Height* - Taken without shoes, with the child standing with heels and back in contact with an upright wall using a height stadiometer
- 5) *Head circumference* - Measured using a non-stretchable measuring tape for children up to 2 years of age
- 6) *Mid-arm circumference* Ensure measurement in same arm (non-dominant) with a non-stretchable measuring tape. (Record to nearest 0.1cm)<sup>3,6</sup>
- 7) *Skin-fold thickness* - Not popular with children and has poor reproducibility in routine clinical usage.
- 8) *Height velocity* - Calculated and plotted over a yearly period
- 9) *Body Mass Index* -  $Wt (kg)/Ht (m^2)^7$
- 10) *Bone age* - Checked annually usually using single AP film of hand and wrist

Standard deviation scores (SDS) relative to age or height (in case of severe growth retardation) must be used when calculating BMI, height, weight, height velocity, mid-arm circumference and skinfold thicknesses.

$$SDS = \frac{[\text{patients actual value}] - \text{value of 50th percentile for controls}}{\text{Standard deviation of control subjects}}$$

Computer packages are available or reference can be made to appropriate tables<sup>3,6</sup>.

\* For premature infants - correct for gestational age, up to 2 years of age, on growth chart

### **C. Clinical/Physical Examination**

The clinical and physical examination combined with the nutritional assessment and monitoring techniques all form part of a paediatric assessment which encompasses many of the following parameters.

- 1) Clinical observations:
  - i) Change in appetite
  - ii) Gastrointestinal problems such as nausea, vomiting, diarrhoea, constipation
  - iii) In infants: gagging, swallowing difficulties and inability to chew solids
  - iv) Energy levels and activity

- 2) Physical observations:
  - i) Condition of hair, teeth, tongue, skin, nails, breath
  - ii) Impression of the preservation or wasting of fat or protein mass
  - iii) Oedema
  - iv) Blood pressure
- 3) Measurements of:
  - i) Urine output for residual renal function
  - ii) Fluid balance
  - iii) Estimated dry weight without oedema

#### **D. Dietary Assessment**

- 1) Diet recall should be routinely discussed in clinic. A 3 day dietary diary should be completed for analysis at baseline and ideally within 3-4 months of commencing dialysis, and 6 monthly thereafter. In infants more frequent adjustments will be required.
- 2) All nutrients should be computer analysed (qualitatively/quantitatively) whenever possible and compared with recommended intakes for children of the same sex and chronological age:
  - i) If the child is within the normal percentile ranges for height (>2nd percentile), energy and micronutrient requirements can be based upon the recommendations for children of the same chronological age (DRV 1991)<sup>8</sup>
  - ii) If the child falls below the normal percentile ranges for height (<2nd percentile), the child's height age may be used to determine acceptable baseline energy and micronutrient requirements when compared with recommended intakes (DRV 1991)<sup>8</sup> and adjusted accordingly thereafter.
- 3) The results should be discussed with the child and family.
- 4) A written report for the nephrologist and responsible renal nurse is advised.
- 5) The dietary analysis should include data on:
  - i) Energy, protein, fat, carbohydrate
  - ii) Vitamins, minerals, trace minerals
  - iii) Fluid and electrolytes

Analysis should include the prescribed nutritional and micronutrient supplements
- 6) In the UK, the dietary reference values (DRV 1991, UK)<sup>8</sup> for food, energy and nutrients is used as the reference source. For other countries national reference guidelines may be available and can be used as baseline requirements for the majority of nutrients. However, protein, phosphate, sodium, potassium and the vitamins folic acid, C and B6 will require individualised prescription, depending upon dialysis losses and biochemical parameters.<sup>9</sup> Protein losses into the peritoneal fluid need to be considered and these are reported to be greater in infants.<sup>10</sup>

#### **E. Biochemical/Haematological Parameters**

- 1) Patient plasma values compared with normal age specific reference ranges will identify abnormalities requiring adjustment in dietary, medications and/or dialysis prescriptions.

- 2) The following indices should be measured at baseline and monthly thereafter:
  - i) Urea, creatinine, sodium, potassium, bicarbonate, albumin\*, calcium, phosphate, alkaline phosphatase
  - ii) Haemoglobin (Hb)
  - iii) Parathyroid hormone (PTH) especially if on Vitamin D metabolites. Intact PTH molecules should be assayed as this more accurately reflects parathyroid activity.
- 3) At baseline and 3 monthly thereafter:
  - i) Glucose
  - ii) % Hypochromic cells and ferritin or serum iron, ferritin and total iron binding capacity (% transferrin saturation TSAT)

Cholesterol and triglycerides can be assessed at baseline but there is no firm agreement on frequency of monitoring or treatment for elevated levels.

\*Serum albumin levels can be affected by many factors and must be interpreted on an individual basis together with the nutritional and clinical assessment<sup>11</sup>.

## **F. Medications**

- 1) Children and their families should be advised on the correct administration and timing of medications to ensure compliance, optimise absorption and minimise potential side effects. Ongoing discussion with education and information about each medication should be routine within each dietetic interview with regular feedback to the medical, nursing staff and pharmacists. Adjustments of particular medications and dosages may be necessary.
- 2) Medications requiring particular monitoring:
  - i) Phosphate Binders  
 Calcium Carbonate should be chewed or crushed to a fine powder or in solution, and taken with food at meal times usually three times daily.  
 Calcium Acetate should be swallowed and not chewed. Sevelamer hydrochloride may be indicated when hypercalcaemia is a problem.  
 Aluminium hydroxide binders should be avoided.  
 (Oral iron supplements should not be taken with phosphate binders)
  - ii) Oral Iron Supplements<sup>12</sup>  
 A dosage of 2-3mg/kg body wt/day is recommended and administered in 2-3 divided doses either one hour before or 2 hours after food. They should not be added to infant formulas or nutritional supplements. If possible they should be prescribed with vitamin C to enhance absorption. (It is important not to over-supplement with vitamin C for risk of increased oxalate formation).  
 Iron supplements should ideally not be taken with phytate (cereals and legumes), tannins (tea, cocoa, chocolate) and dairy products which interfere with absorption.
  - iii) Diuretics and Antihypertensives  
 Can alter balance of minerals
  - iv) Antibiotics  
 May cause diarrhoea (sometimes confused with nutritional supplements/tube feeding) and some can interfere with vitamin metabolism
  - v) Micronutrient Supplements

Should be prescribed only following individualised dietary assessment and should account for the potential CPD losses of folic acid and vitamins C and B6 as shown in adult studies<sup>12</sup>. Recommended intakes are based on the reference nutrient intake (RNI, DRV 1991<sup>5</sup>) and from the few paediatric studies available<sup>13,14,15,16</sup> would suggest intakes of:

- a) vitamin C 25 (infants)-60mg/day
- b) vitamin B<sub>6</sub> 0.2 (infants)-1.5mg/day
- c) folate 60 (infants)-400µg/day

All other vitamins and trace minerals should meet with 100% of the reference nutrient intake (DRV, RNI 1991) with the exception of vitamin A, which should not exceed 100% of the RNI and should not be present in prescribed micronutrient preparations.<sup>3,14,17</sup>

### **G. Dialysis Prescription**

Dialysis prescriptions (dose of dialysis, dialysis cycle times, dialysis solution(s), ultrafiltration, urine output) should be monitored on a monthly basis in clinic by the nephrologist, renal nurse and dietitian. Ongoing monitoring should take place on a weekly basis by the renal nurse(s) by telephone with discussion at team meetings.

Dialysis adequacy assessments and peritoneal equilibrium tests are discussed in another guideline.

### **H. More Detailed Assessments to Assess Body Composition**

- 1) Dual Energy Xray Absorptiometry (DEXA) is a non-invasive method to estimate bone mineral content, fat and lean body mass. It is not widely available and requires expertise in use and patient co-operation. Estimates may be confounded by variations in hydration states in PD patients. Moreover the cost of DEXA makes it feasible no more than annually.<sup>18</sup>
- 2) Bioelectrical Impedance (BI) allows the measurement of fat free mass in healthy children, but it is not widely available. However, it is fast, easily applied, repeatable and relatively inexpensive. It should be noted that results in PD patients may be confounded by variations in hydration states. It is debatable whether direct measures (resistance, reactance, phase angle, distance) or indirect (that is, equation derived) measures should be used in clinical practice. BI should only be used in combination with anthropometric/clinical assessments.<sup>18</sup>

Both DEXA and BI are not essential parameters to be included within the nutritional assessment process and will depend on individual unit protocol.

### **I. Psychosocial Assessment**

- 1) As part of the overall nutritional assessment it is essential for the dietitian, as a key member of the multidisciplinary team, to become familiar with each child's psychosocial environment which includes:
  - i) Family/extended family dynamics
  - ii) Lifestyle, activities, exercise patterns
  - iii) Friends, hobbies
  - iv) Nursery/school attendance
  - v) Eating patterns in/out of home

- 2) A home visit made by the dietitian with the renal nurse or social worker prior to, or at the initiation of, a child onto a CPD programme is recommended. Further “update” visits at 6-12 months should be considered in children on combined enteral nutritional support and dialysis.<sup>19</sup>

#### **J. Formulate Nutritional Prescription**

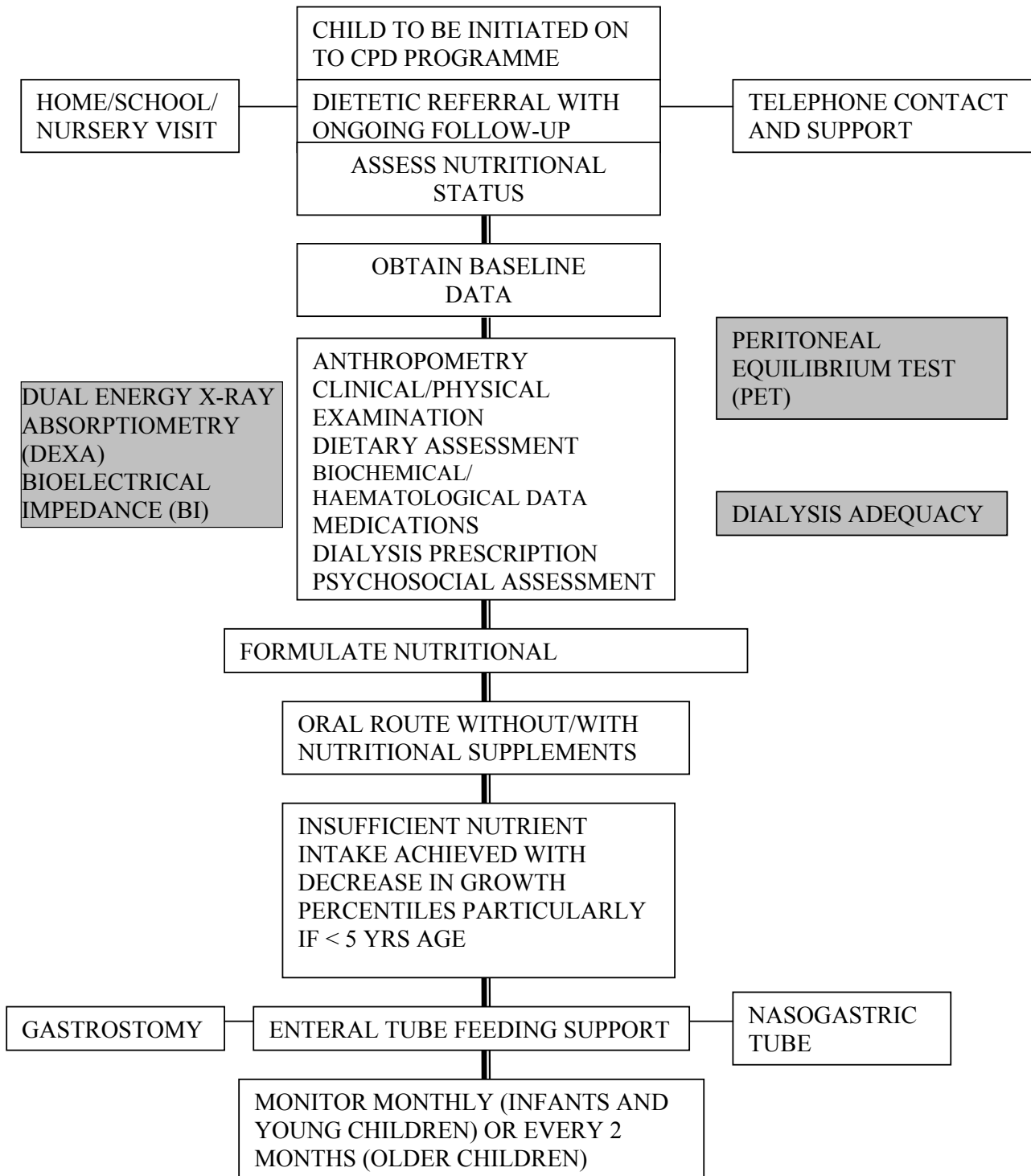
- 1) The dietitian having considered all of the nutritional assessment parameters will calculate individual nutritional requirements (Table 2).<sup>1</sup> These goals will be discussed with the child, family and nephrologist to formulate the nutritional prescription.
- 2) The oral route should always be considered. However, the early initiation of enteral nutrition support with use of nutritional supplements given orally or via an enteral tube feeding route (gastrostomy or nasogastric tube)<sup>20,21</sup> should be considered when:
  - i) the child’s oral intake fails to meet recommended nutritional intakes and/or
  - ii) the child fails to maintain adequate growth velocity (for example, when weight, height and/or head circumference measurements begin to fall from percentiles and height velocity is consistently below the 25th percentile) and
  - iii) other non-nutritional causes are excluded.
- 3) All children, but particularly infants and children < 5 years of age should be considered for the combined initiation of dialysis and overnight enteral nutritional support via a gastrostomy button or nasogastric tube<sup>21</sup>. If enteral nutritional support via a tube feeding route is considered, it is essential for all team members to ensure a common philosophy with understanding of the ongoing support which will be required for this treatment to be successful. Team discussion followed by counselling of each child and family with the use of booklets, children’s stories and videos is recommended. Meeting another child/family undergoing or having undergone such management is recommended.
- 4) Nutritional supplements suitable for paediatric use are shown in Table 3.<sup>1</sup> These are the supplements commonly in use in the UK and can be compared to those available in other countries.
- 5) Age related normal weaning, feeding and eating skills should be encouraged.

#### **K. Recombinant Human Growth Hormone (rhGH)**

Recombinant hGH would be considered in PD patients with growth potential only after nutritional parameters have been corrected along with acidosis, hyperphosphataemia and secondary hyperparathyroidism<sup>3</sup>. Evidence is accumulating that intensive nutritional support and adequate clearances in prepubertal patients promote normal and enhanced growth without rhGH<sup>22,23</sup>.



**Table 1**  
**Nutritional Assessment for Children on CPD**



■ Will depend on individual unit protocol and should only be used in combination with clinical, biochemical and anthropometric assessment

**Table 2**  
**Nutritional Recommendations for Children on CPD<sup>1</sup>**

	Energy (kcal/kg body wt/day)	(kJ)	Protein (g/kg body wt/day)	Phosphate (mg/day)
<b>Peritoneal dialysis (CCPD/CAPD)</b>				
Infants				
Preterm	120-180	500-750	3.0-4.0	<400mg (<10kg body weight)
0-0.5yr	115-150	480-630	2.1-3.0	
0.5-1.0	95-150	400-630	2.0-3.0	<600mg (10-20kg body weight)
1.0-2.0	95-120	400-500	2.0-3.0	
Children/adolescents				
2.0-puberty	Minimum of EAR for chronological age (use height age if < 2nd percentile for height)		1.5-2.0	<800mg (20-40kg body weight)
pubertal			1.4-1.8	
post-pubertal			1.3-1.5	<1000mg (>40kg body weight)

These are guidelines which will require adjustments based on individual nutritional assessment  
 EAR – Estimated average requirement (Dietary Reference Values, 1991)<sup>8</sup>

**Table 3**  
**Nutritional Supplements<sup>1</sup> Used for Children on CPD (available in the UK)**

Supplement	Suggested Use
Energy Glucose polymers (powder) eg Polycal, Supersoluble Maxijul (SHS Ltd), Polycose (Abbott Labs)	Add to infant formula, baby juice, cows' milk, water, squash, fizzy drinks, tea, milk, ice cubes and lollies
(liquid) eg Polycal (Nutricia Ltd), Maxijul (SHS Ltd)	Dilute with soda water, fizzy drinks of choice, squash (unless fluid restricted); add to jelly
Fat emulsion eg Calogen, Liquigen (SHS Ltd) Combined fat and carbohydrate eg Supersoluble Duocal Powder, Liquid Duocal (SHS Ltd)	Add to infant formula, cows' milk, nutritionally complete supplements
Protein Protein powders eg Protifar (Nutricia Ltd), Supersoluble Maxipro HBV (SHS Ltd), Renapro (Kimal Ltd)	Add to infant formula, Liquid Duocal, modular energy components
Renal Specific Infant Formula Kindergen PROD (SHS Ltd) Powder/100g (7.5g protein, 507kcal, 93mg phosphate, 3mmol potassium, 10mmol sodium) 20g powder made up to 100ml with water (1.5g protein, 101kcal, 18.6mg phosphate, 0.6mmol potassium, 2mmol sodium)	A combination of Kindergen PROD with a normal infant formula may be indicated to maintain plasma phosphate and potassium levels
Nutritionally Complete Nutrini (2.75g protein, 100kcal, 39mg phosphate, 2.6mmol potassium, 2.3mmol sodium/100ml) (Nutricia Ltd) Nutrini Extra (3.4g protein, 150kcal, 50mg phosphate, 4mmol potassium, 3.5mmol sodium/100ml) (Nutricia Ltd) Fortijuce (4g protein, 125kcal, 60mg phosphate, 0.65mmol potassium, 0.52mmol sodium/100ml) (Nutricia Ltd) Fortisip (5g protein, 150kcal, 80mg phosphate, 3.75mmol potassium, 3.44mmol sodium (sweet and neutral); 7.1mmol (savoury)/100ml) (Nutricia Ltd) Suplena (3g protein, 201kcal, 79mg phosphate, 2.87mmol potassium, 3.48mmol sodium/100ml) (Ross Labs) Nepro (6.99g protein, 200kcal, 72mg phosphate, 2.69mmol potassium, 3.48mmol sodium/100ml) (Ross Labs)	For oral or supplementary tube feeding in infants/children >8 months age and weight >8kg
Low Protein Milk Substitute Sno-Pro (0.22g protein, 67kcal, <30mg phosphate, <1.3mmol potassium, <3.3mmol sodium, <15mg calcium/ 100ml) (SHS Ltd) Renamil (nutritional composition will depend upon prescribed powder to volume) (Kimal Ltd)	Use as a substitute for cows' milk to reduce protein and phosphate intakes

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## **ADDENDUM**

### **Manufacturers of Dietetic Products**

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Uxbridge  
Middlesex UB8 2SA  
UK

Ross Laboratories  
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Moorbridge Road  
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